The evaluation of selected indicators of water quality in observed watersheds in Znojmo region

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Abstract: The paper is focused on the monitoring of selected water quality parameters in watersheds of Březanka and Trstěnice stream due to land use categories. Measuring point at each flow was elected according to the borders of different land use categories because of demonstrating the effect of individual category on the water quality. Since March 2014 there has been measurement monthly taking place on chosen sites and followed by laboratory analysis of water in the laboratory of the Mendel University in Brno and comparing the results with actual legislation.
Results of laboratory analyzes demonstrate the self-cleaning process of individual sections of streams, which are noticeable changes in the concentrations of monitored indicators of water quality. The results confirmed the assumption that forest land use category shows the highest degree of self-cleaning water.
One of the main results are the average values of phosphorus in Trstěnice stream 0.26 mg. l^{-1} and 0.87 mg. l^{-1} by the Březanka stream, where according to the law announcement is allowed only the value of 0.15 mg. l^{-1}. Further, the nitrate nitrogen with mean values of 17.8 mg. l^{-1} and 16.2 mg. l^{-1}, compared with ordinance stipulating 5.4 mg. l^{-1} and last but not least conductivity mainly on Březanka stream showing 177.5 $mS.m^{-1}$ instead of normal 160 $mS.m^{-1}$. The high rate of conductivity, according to CSN, points to the grade indicating a quality of polluted, heavily and very heavily polluted water, which points to run-off from agricultural lands. In place of the sharp decline do not take place the large areas of fields. Levels of phosphorus and nitrogen showed higher values for the both flows, mainly in agriculturally used land ends and urban areas, which were subsequently reduced after passing through the forest vegetation by several orders. The main problem is usage of phosphate and nitrogen in agricultural land fertilizers and household washing and cleaning detergents containing polyphosphates, which WWTP cannot completely remove. The great influence of the forest is in removing these substances, namely vegetation uses a lot of nutrients (nitrogen and phosphorus). All measured values indicate the emergence of eutrophication and degradation of natural habitats.

Key-Words: Březanka and Trstěnice stream, land use, self-cleaning process, water quality, monitoring, laboratory analysis

Introduction

Water is high substantial factor for formation stronger landscape stability [1].

Trstěnice even Březanka stream is located in municipality district of the town Zlín in South Moravia Region. Both sites are 2 km far from the town Zlín and 45 km far from Brno city. The area belongs to the Black Sea drainage, the Danube basin, sub-basin of Thaya.

The Březanka stream (originaly Mackovice stream) springs in the Mackovice cadastral; there are two ponds on the stream. The Březanka stream near the village of Hrusovany upon Jeviškovka empties into the Jevišovka river. Březanka´s catchment area is 5.49 km^2 [2].

Trstěnice stream sprint in the cadastral of the village Trstěnice, subsequently flows into the Skalička stream that discounts with Jevišovka river. The catchment area is 6.05 km^2 [3]. There are two small water ponds.

It has established a total of ten sampling profiles for water sampling, which, according to set parameters further processed and evaluated.

Nitrogen and phosphorus are the main elements causing eutrophication and determining its scope. The

increase in phosphorus and nitrogen in the monitored areas is mainly due to the human factor.

Eutrophication processes cause excessive occurrence of certain species of cyanobacteria and algae along with the associated health risks.

Detergents in wastewater and surface runoff from farm soil and fertilization are considered the main sources of pollution [1].

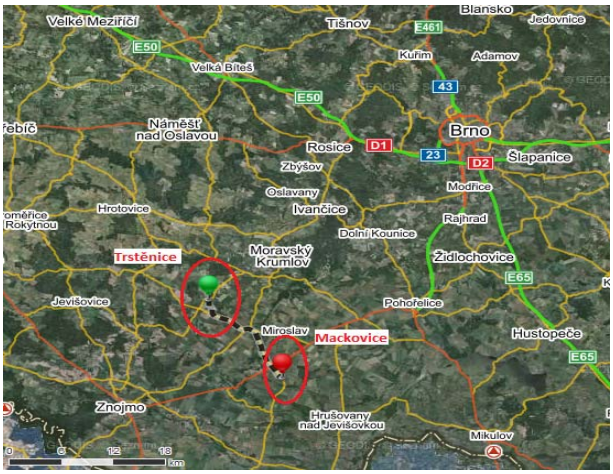
The concentration of nitrate is the basic indicator of farming on the surrounding land [4]. Nitrates are concentrated in surface waters. It´s sources are mainly fertilization, mineralization of plants residues and atmospheric water. High leak of nitrates form agriculture processes (fertilizers) is decreases with the help of legislative support so-called Nitrates Directive [5].

COD means the amount of oxygen consumed for the oxidation of organic substances, which is an indicator of total organic pollution of surface waters, according to which it can judge the importance of self-cleaning process in a flow. The value of COD is therefore a measure of the total content of organic substances in water [4].

Phosphorus gets into water from fertilizers, detergents, leaching soils etc. It is a limiting factor in the waters and their processes, because its value is compared to others constant or continuously increasing. Phosphorus in waters occurs mainly in the form of phosphates [6]. Phosphorus compounds are important for the cycling of matter in nature and are key to the eutrophication of surface waters [4].

Conductivity (concentration of electrolytes in the water) depends on the concentration of ions, their charge, mobility and temperature [4]. This is the concentration of ion solutes and total water mineralization.

Fig. 1 definition of the area – represented by the red circle (www.mapy.cz, edited by the author)



There are several options to reduce these indicators in the water, one of them are self-cleaning flow processes. These processes are dependent on the type and use of the landscape. According to laboratory analysis of water quality and the use of land use categories best practices for sound land use in terms of water pollution will be evaluated.

Materials and Methods

Sites

Sampling is carried out from April 2014 and as part of the thesis will continue until March 2015, so it is a yearly measurement of water quality at selected sections of two streams. Each of these streams is monitored in five sites.

The first profile on Březanka stream is its spring located directly on agricultural land, which was this year especially in the dry summer months. The second one is located on the border of the farming land with the edge of small local woods. The third one is located flow down the water pond; the fourth on the end of the village, under the outfall of waste water treatment plant and the fifth is under the next water pond in a small wood above the confluence with the amelioration system.

The first site on the Trstěnice stream is not directly the spring of the stream, because it is permanently dry this year. An unnamed tributary was therefore designed as a site, which passes around the farm, intended for breeding pigs. The second site is situated in the wood below two ponds and right on the confluence with the Trstěnice stream. The third one is on the end of boundaries of the village, where there is the outfall of waste pipe. The fourth site in located on the border of farmland and wood. The last site is in the wood above the confluence with the Skalička stream.

Sampling in the field

Samples are collected monthly, at about the same time, into plastic bottles, which are subsequently kept refrigerated and processed within 24 hours in the laboratory. Additionally on the sites the water temperature, dissolved oxygen, pH and electrolytic conductivity are measured by portable multimeter HQd (HACH LANGE Company)

Laboratory Processing of Samples

Samples are processed in the laboratory of the Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University (DALE). All samples are processed according to standardized methods pursuant to the Hach Lange methodology on the spectrophotometer DR 4000. Subsequently the

results are graphically presented, evaluated and compared with the actual law.

Fig. 2 picture of the selected profiles (www.mapy.cz, edited by the author)

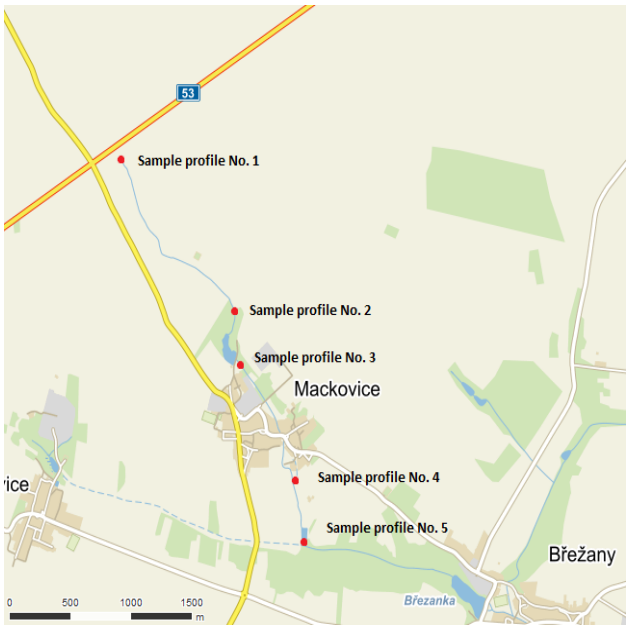


Fig. 3 picture of the selected profiles (www.mapy.cz, edited by the author)

Results and Discussion

Comparison of the Results

The results from sampling and measurement on both streams present self-cleaning processes of individual stream parts and there are evident changes in concentrations of observed indicators of water quality. These results were compared with the environmental quality standard for bodies of surface water, according to Government Regulation No. 61/2003 and CSN 75 7221.

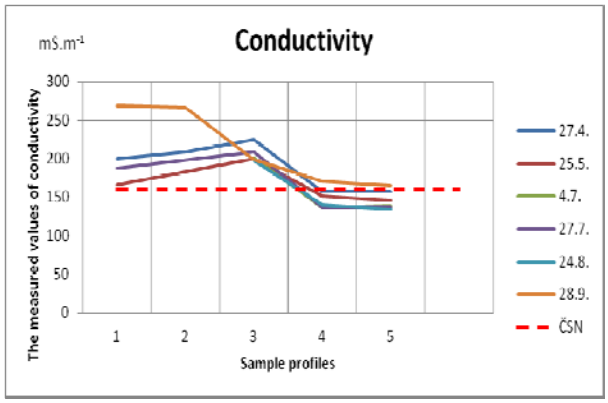
Březanka Stream´s Resultes

Levels of phosphorus, nitrate nitrogen, COD and conductivity measurements exceed the legal standards according to the resulting analysis. After evaluation of the sampling sites and their surroundings using land use, the fastest growth of these values is visible on site of the urban village under the water tank (sampling profile No. 3). Positive results of self-cleaning process are noticeable especially after the passage of the forest (sites No. 2 and 5).

The increase of phosphorus concentration was gradual and the values were the highest at sites No. 3 and 4. It is therefore primarily a problem of application of phosphate fertilizers on agricultural land use and household washing and cleaning agents containing polyphosphates [7], which subsequently WWTP will not be able to completely remove. Lower values for the profile No. 5 confirmed the great influence of the forest in removing this material, vegetation uses a lot of nutrients (nitrogen and phosphorus).

Nitrate nitrogen was highest in site No. 4, so it is a problem of increased minerals. Wastewater is the significant factor. Sites within farming area show increased incidence of nitrates which probably come from nitrogenous fertilizers. Even the first site shows higher concentration of nitrates, reduction of nitrogen emissions from livestock would be an appropriate countermeasure [5].

Fig. 4 – Values of conductivity in Březanka stream and the Environmental standard according to CSN (author)



The lowest value is on the third site (downstream the pond), where the reduction nitrates into nitrites is done (denitrification), and on the fifth site which is affected by the wood ecosystem with lot of fytoplankton in the surface water, which drains the nutrients from water and use them for body construction.

The COD was commonly the highest on the third site under the water tank. The water tank and its surrounding is contaminated with organic polluters, e.g. leaching from soil, leaves and waste water.

The conductivity was measured in the field and its high rate, according to CSN, points to the third, fourth and fifth grade indicating the quality of polluted heavily and very heavily polluted water [8]. Conductivity increases between the first and the third profile, which points to runoff from agricultural land.

Trstěnice Stream's Results

According to the results, values of phosphorus, nitrates nitrate, COD and dissolved oxygen were higher than the standard.

Curve of phosphorus refers to the highest representation in the consumption profile No. 3, (in the village), which points to the fact that the municipality does not have a WWTP. The fourth site (beginning of forest) has also elevated levels, so at the end of the agricultural land where contamination may be similar to the case of the Břežanka stream and the site No. 1, which is located in a field behind the building for a pig factory farm. On all other (forest) sites there are mostly in decline or stagnation of this element.

High concentrations of nitrate nitrogen were observed already in the first site; the effects on such results have surely economic object and nitrogen fertilizer applied to the land. Among the first and the second site, there was the self-cleaning process. On the rest of monitored location there was a slight increase of nitrate nitrogen which is probably caused by wastewater from municipalities and leaches nitrogen compounds from fields.

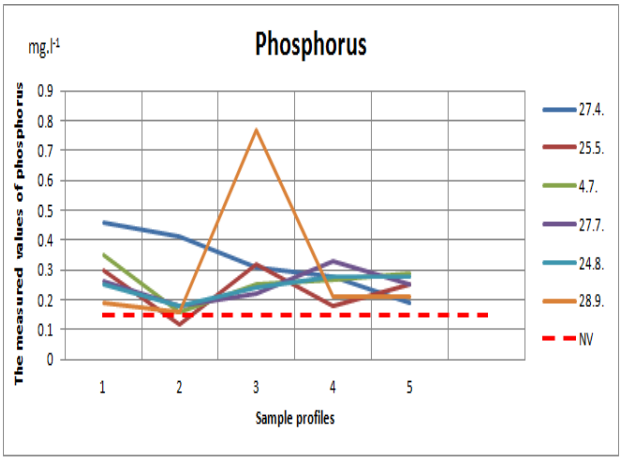
COD had a huge increase in profile No. 3 (below the village) and profile No. 4 (fields), this result points again to the waste from agriculture and extracts of these soils. Other sites´ values of COD were below the standard according to the notice, but is also worth mentioning site No. 2 (in the forest), which had also increasing the value that was mostly due to natural pollution (leachate from decaying wood or plant products and animals) [4].

The level of conductivity is largely located in the third group of surface water quality, according to CSN, which means the water has been polluted [8]. The high degree of conductivity indicates a high concentration of dissolved salts (minerals) that are present in such a large extent, mainly due to nutrient runoff from cultivated fields. It was also proved the rule that a change in temperature causes a change of conductivity. PH is indeed normal, but most of the time with the profile no. 1 found elevated levels that gradually drop to profile No. 4, which has the lowest value. PH on these sites shows the existence of lush aquatic vegetation on runoff of soil from deciduous forests and, last but not least, the possible evasion or violation of procedures or slurry storage and its application to the farmland [9].

If the pH is increased due to the photosynthetic assimilation of green plants, which leads to depletion of free carbon dioxide[4], so reduce the pH can be achieved by cuting-out lush local vegetation, thereby limit photosynthesis [7].

After evaluation of the sampling sites and their surroundings using land use, the fastest growth of these values is visible on site of the urban village (sampling site No. 3) and on the first site. Positive results of self-cleaning process are noticeable especially after the passage of the forest (sites No. 2 and 5).

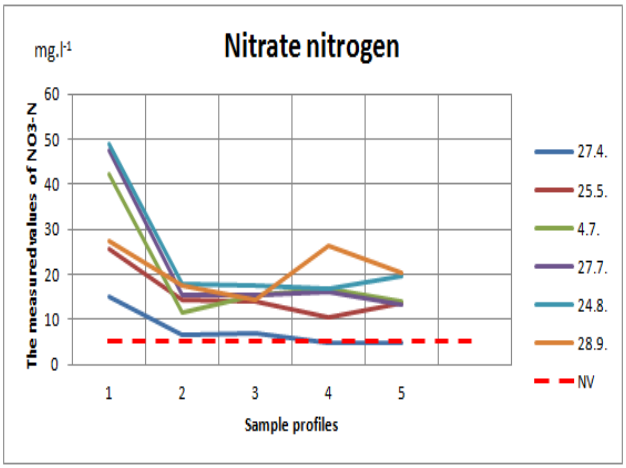
Fig. 5 – The amount of phosphorus in the selected profile Trstěnice and the level of premissible phosphorus amount (NEQ) (author)



Overall recommendations, as the context requires, are based on the application of phosphate limitation and nitrogen fertilizer on agricultural land use and household detergents containing polyphosphates. Construction of wastewater treatment plant in the village Trstěnice and in the village Mackovice greater control of phosphorus discharged is another useful measure, as well as increased checks on possible leaks or failure to observe the storage of slurry or its application to the farmland.

To support all three phases of processes (physical, chemical and biological) is necessary for self-cleaning process [1]. Creating infiltration strips around streams near the fields would limit the quantity of substances released into surface waters through run-off [10]. The construction of wetlands, planting of vegetation for greater oxygen supply, leading stream boulders or support aquatic fauna also will support self-cleaning processes.

Fig. 6 – The amount of nitrate in the selected profile of Trstěnice and the level of permissible nitrate amount (NEQ) (author)



Conclusion

The confirmation that different land use has different effects on the water quality is the main output. The selected points on the borders of individual land use categories point to the fact water quality changes in a negative sense, especially on farmed land, urban areas of municipalities and local wastewater treatment plant, where the levels of phosphorus, nitrate nitrogen, COD and conductivity generally increased. Conversely, positive changes in the concentrations of the indicators confirmed the assumption that the use of forest land for the process of self-purification of water is the best option. Appropriate measures for self-purification capacity in the most polluted sampling sites were recommended. Sampling, analysis and processing laboratory analysis and studying of recommended measures will continue.

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